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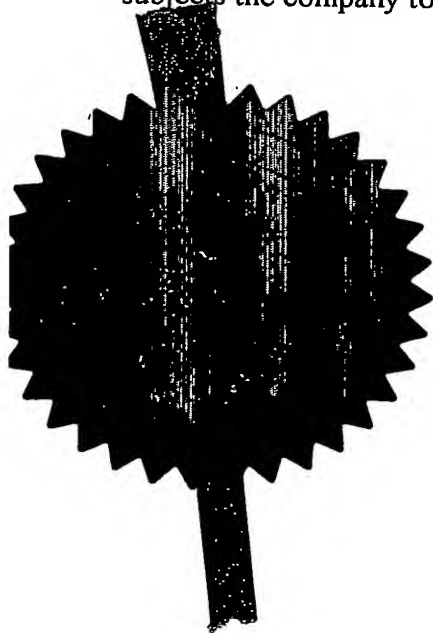
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R. Mahoney

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P01/7700 0.00-0225903.4

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3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

SIEMENS AKTIENGESELLSCHAFT

WITTELSBACHERPLATZ 2
D-80333 MUNICH
GERMANYPatents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

DE

5072445001

4. Title of the invention

METHOD FOR UPLINK ACCESS TRANSMISSIONS
IN A RADIO COMMUNICATION SYSTEM5. Name of your agent *(if you have one)*

DEREK ALLEN

*"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)*Siemens Shared Services
Intellectual Property Department
Siemens House, Oldbury
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Country

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Number of earlier application

Date of filing
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YES

a) *any applicant named in part 3 is not an inventor, or*b) *there is an inventor who is not named as an applicant, or*c) *any named applicant is a corporate body.**See note (d))*

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Claim(s) 3

Abstract 1

Drawing(s) 5

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Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77) 1

Request for substantive examination (Patents Form 10/77)

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Fee Sheet

11.

I/We request the grant of a patent on the basis of this application.

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DEREK ALLEN

Date 06/11/2002

12. Name and daytime telephone number of person to contact in the United Kingdom

DEREK ALLEN

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DUPLICATE₁

METHOD FOR UPLINK ACCESS TRANSMISSIONS IN A RADIO COMMUNICATION SYSTEM

Field of the invention

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The invention relates to a method for uplink access transmissions in a radio communication system, especially in a mobile communication system.

10 Background of the invention

In radio communication systems, signals are exchanged between radio terminals and radio stations to base stations via a so called radio interface or air interface. These radio terminals are mobile or stationary user terminals (UE - user equipments); base stations (NB - Node B) are access stations that are associated with a land based communication network. Examples of known radio communication systems are second generation digital mobile radio communication systems like GSM (Global System for Mobile Communication) based on TDMA (Time Division Multiple Access) and providing data rates up to 100 kbit/s, or third generation digital mobile radio communication systems like UMTS (Universal Mobile Telecommunication System) based on CDMA (Code Division Multiple Access) with data rates up to 2 Mbit/s.

In such systems, for some cellular radio services it may be necessary or desirable to count the number of user equipments, possessing a particular characteristic, that are present within a cell of a base station, up to the point where the count is equal to a particular number (threshold), or, if there are less than the threshold number of user equipments present, for a defined period of time. One method of imple-

menting such a process, when the network has no prior knowledge of the user equipments presence in the cell, would be for the cellular network to signal to the user equipments possessing the characteristic that they should make a response signal on a contention access, common uplink signalling channel, thereby enabling the network to count the responses. Unfortunately, if there is a large number of user equipments in the cell, this could lead to the overloading of the common uplink signalling channel with a consequent risk of disruption to the operation of the cell.

A particular example of where this problem may occur is within UMTS the so called MBMS (Multimedia Broadcast/Multicast Service) service provision. Radio bearers for multicast MBMS services are set up within a cell only if there are user equipments present in the cell with the particular MBMS service activated. If the number present is below a threshold value then radio bearers are established individually to each of the user equipments (point-to-point bearers) whilst if the number exceeds the threshold value a single multicast radio bearer is established to serve all user equipments that are present in the cell. Consequently, the network needs to know whether the number of user equipment present in the cell exceeds the threshold and, if less than the threshold number are present, the identities of the user equipments. For user equipments that are in the so called UMTS connected mode, then the network can know the number present in the cell with the particular MBMS service activated without communicating directly with the user equipments. For user equipments that are in an unconnected state, e.g. in a so called idle mode or URA_PCH state, then the network will need to signal a request to the user equipments, e.g. by paging or control channel signalling, and the user equipment

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will need to respond on the RACH (Random Access Channel) common uplink signalling channel. Counting of user equipment responses should be completed within a determinate time interval and a decision for the establishment or not of a single multicast radio bearer taken based on the result.

In current mobile networks access to contention access channels like the RACH is controlled individually by the user equipment selecting an initial delay period that should elapse before the user equipment transmits. This initial delay may be uniformly distributed, like in GSM, or effectively negative exponentially distributed, like in UMTS. These forms of initial delay distributions are well suited for responses to the selective paging of individual user equipments where simultaneous access attempts from large numbers of user equipments are unlikely. However, they would not be effective in preventing overload in the contention access channel when many user equipments are paged simultaneously as would be the case for the group page described above.

Object of the invention

An object of the invention is to provide a contention access control mechanism which enables a counting process to be completed whilst reducing the probability of overload in the uplink signalling channel used.

Statement of the invention

The invention relates to a method for uplink access transmissions in a radio communication system, wherein a user equipment determines a delay time for transmitting a signal on an uplink access channel, wherein the delay time is randomly de-

terminated based upon a probability distribution that increases in density with increasing delay.

Brief description of the figures

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The invention may be understood more readily, and various other aspects and features of the invention may become apparent from consideration of the following description and the figures as shown in the accompanying drawing sheets, wherein:

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FIG 1 shows a block diagram of a radio communication network,

FIG 2 shows an illustration of a threshold triggered termination of responses,

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FIG 3 shows a flow chart of the initial delay selection,

FIG 4 shows a first message exchange chart, and

FIG 5 shows a second message exchange chart.

Detailed description of the invention

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FIG 1 shows the basic structure of a UMTS mobile radio system. The system consists of a central mobile switching center MSC which is connected to the public switched telephone network PSTN and other MSCs. Connected to a MSC is a plurality of radio network controllers RNC, which inter alia coordinate the sharing of the radio resources provided by base stations NB (Node B). Base stations NB transmit in downlink DL and receive in uplink UL signals respectively to or from user equipments UE situated within the area covered by the base station NB. In FIG 1 the base station NB sends out a request for the activation of an MBMS multicast service on a paging channel PCH to the user equipments in its cell. The user equipments interested in this service or possessing the par-

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ticular characteristic respond to the request by sending an access message on the contention based access channel RACH.

5 The contention access control scheme according to the invention makes use of the following realisations.

Before responding to a network request, received for example as a page on a paging channel PCH or as a message on another control channel, and transmitting on a common uplink contention access channel, e.g. RACH, the user equipment calculates
10 an initial delay time. The delay time is selected at random using a probability distribution that increases in density with increasing delay and which is bounded above by a time T. An advantage of such a distribution is that the likelihood of
15 collisions of response messages from different user equipments is reduced, thereby facilitating the counting procedure and making it more reliable.

An example of continuous distribution having these probabilities
20 is the following:

$$p(t) = x \cdot e^{xt} / (e^{xT} - 1) \quad \text{for } t \in [0, T] \quad (1)$$

where $p(t)$ denotes the probability that a delay time t is selected, T denotes the maximum delay time permitted, and x is
25 a parameter that controls the rate of change of probability with time.

The parameters T and x are known in the user equipment or may
30 be signalled to the user equipment by the network with the page or a control channel signal.

An equivalent example for the case where the time interval T is sub-divided into n , equal length, sub-intervals (e.g. UMTS transport time intervals) is the following:

$$p(j) = q^{n-j} \cdot (1-q) / (1-q^n) \text{ for } j \in [0, n] \quad (2)$$

where $p(j)$ denotes the probability that sub-interval j is selected ($j = 1$ denotes the shortest time delay) and q is a parameter that controls the rate of change of probability with sub-interval.

The parameters T , n and q are known in the user equipment or may be signalled to the user equipment by the network with the page or a control channel signal.

FIG 2 illustrates the selection procedure of the user equipment for an initial RACH access delay when the probability distribution described by equation (2) above is applied.

If the network detects that the number of user equipments responding to the request exceeds the threshold for terminating the response procedure, it signals to all user equipments that they should cease making further uplink contention access transmissions in response to the page or control channel signal. The network then establishes a single multicast radio bearer and activates the MBMS service.

The termination may be explicit, for example by transmitting a dedicated termination signal to all user equipments, or implicit, for example by signalling an allocation of resources for a multicast MBMS radio bearer which also indicates that the user equipment counting phase has been completed and

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no more uplink common channel responses should be transmitted by user equipments in respect of this request.

In case the network receives less than the threshold number of responses within time interval T , it assumes that the number of user equipments interested or possessing the particular characteristic present in the cell is equal to the number of responses received and terminates the counting procedure. It then establishes radio bearers individually to each of the user equipments and activates the MBMS service.

By the use of these procedures it is achieved that all user equipments responding to the page or control channel request signal will select a transmission delay that is at most T seconds, which enables the network to receive responses within a defined time interval. If less than the threshold number of user equipments present in the cell are required to signal a response then all should transmit a response within this time interval. The rate at which user equipments respond should increase as time increases towards T . Because the network counts the number of responses that are made and is able to terminate further responses when the threshold number has been exceeded it should be possible to avoid overload of the uplink common channel, for example the RACH, on which the responses are transmitted.

An example of the principle is shown in FIG 3. Where less than the threshold number N_T of user equipments are present in the cell, all should commence the transmission procedure within time T , this is illustrated by the line terminating at N_1 . Where there are greater than N_T user equipments present in the cell, then transmission will be terminated when the threshold number N_T of responses has been received. Signal-

ling delays may result in some responses being received after the threshold has been crossed. Selection of suitable access distribution parameters, for example x and T or q , n and T identified above, should enable termination of response transmissions before overloading of the uplink contention access channel occurs.

It is though possible that user equipments may fail to receive respectively the page or the request sent on a control channel, or the network may fail to receive responses from user equipments. Different procedures may be used for alleviating the effects of such losses. According to a first procedure, the requests sent on paging or common channels are repeatedly transmitted in order to increase the likelihood that an user equipment will receive the request. Additionally, the magnitude of parameter T could be reduced with each successive request to ensure that user equipments responding to the separate requests initiate responses before a common point in time. According to a second procedure, responses are retransmitted by user equipments, provided that the ending of the counting procedure has not been signalled by the network, if the user equipments transmission has not been acknowledged by the network within a period of time. An identifier signalled by the user equipment in its response could thereby be used by the network for the acknowledgement. In this case the time that the network monitors before assuming that all user equipments have responded may exceed T .

The invention allows the network to control user equipment access to the uplink contention access channel in a way that changes the density of transmissions with time for a variable number of users in a cell. Furthermore, the invention enables the network to stop uplink response transmissions when a

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threshold number of responses have been received, thereby preventing overload of the uplink signalling channel. The uplink control method also ensures that all user equipments should attempt to respond within a defined time interval.

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FIG 4 shows an example of a message sequence chart that illustrates the operation of the access control mechanism when less than the threshold number of user equipments are present in the cell, and it makes use of the described optional network acknowledgement and user equipment retransmission protocol.

After the transmission of a request by the network to the user equipments UE1, UE2, UE3, for the establishment of a MBMS multicast service, the user equipments each respond to the request by transmitting a response message back to the network at different instances determined by using equation (1) or (2). In case of detected collisions, the user equipments would retransmit the responses after a determined retransmission interval (dashed line). Unfortunately, the response of the user equipment UE1 is corrupted during the transmission and cannot be detected by the receiving network. The network then acknowledges the receipt of the responses from the user equipments UE2 and UE 3 by transmitting an acknowledgement message, containing indicators of user equipments UE2 and UE3. Failing to receive an acknowledgement from the network, the user equipment UE1 retransmits the response message to the network before the lapse of the timer interval, which this time is well received by the network. In this example it is assumed that the threshold number of responses is greater three. As the number of responses before lapse of the timer interval is three, i.e. user equipments UE1, UE2 and UE3, the network sends out one or several messages

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signalling to the user equipments that no further responses should be sent (Terminate Responses), and that the service will be established on ressources assigned by the network (Ressource Assignment) -

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In the example of FIG 5, the responses of user equipments UE1, UE2 and UE3 are received and acknowledged by the network, and a fourth user equipment UE4 responds to the paging of the network. Because this time the number of responses exceeds the threshold before lapse of the timer interval, the network sends out messages for terminating the sending of responses by the user equipments and assigns a single multi-cast channel to serve all user equipments in the cell of the base station, even though eventually not all of the user equipments sent a response to the network.

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Claims

1. Method for uplink access transmissions in a radio communication system, wherein
- 5 a user equipment (UE1,UE2,UE3,UE4) determines a delay time for transmitting a signal on an uplink access channel (RACH), wherein the delay time is randomly determined based upon a probability distribution that increases in density with increasing delay.
- 10 2. Method according to claim 1, wherein the delay time is determined upon receipt of a request from a base station (NB).
- 15 3. Method according to claim 1 or 2, wherein the base station (NB) transmits the request on a paging channel (PCH) or on a control channel.
4. Method according to one of the previous claims, wherein
- 20 the user equipment (UE1,UE2,UE3,UE4) transmits as signal a response signal on a contention based common uplink access channel.
5. Method according to one of the previous claims, wherein
- 25 the probability distribution is determined according to:

$$p(t) = x \cdot e^{xt} / (e^{xT} - 1) \quad \text{for } t \in [0, T]$$

- where $p(t)$ denotes a probability that a delay time t is selected, T denotes a predetermined maximum delay time, and x is a parameter that controls the rate of change of probability with time.
- 30

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6. Method according to one of the claims 1 to 4, wherein the probability distribution is determined according to:

$$p(j) = q^{n-j} \cdot (1-q) / (1-q^n) \text{ for } j \in [0, n]$$

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where n is the number of sub-intervals in a predetermined time interval T, p(j) denotes a probability that sub-interval j is selected, and q is a parameter that controls the rate of change of probability with sub-interval.

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7. Method according to claim 5 or 6, wherein the parameters are signalled to the user equipment (UE1, UE2, UE3, UE4).

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8. Method according to claim 7, wherein the parameters are transmitted together with the request.

9. Method according to one of the previous claims, wherein the network determines if the number of user equipments

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(UE1, UE2, UE3, UE4) responding to the request exceeds a predetermined threshold for terminating the response procedure, whereby the network signals to the user equipments (UE1, UE2, UE3, UE4) to terminate further uplink access transmissions if the threshold is exceeded.

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10. Method according to claim 9, wherein the network transmits a dedicated termination signal to the user equipments (UE1, UE2, UE3, UE4), or signals an allocation of resources, thereby implicitly indicating the termination.

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11. Method according to claim 9 or 10, wherein dependent on the determined number of responses received from the user equipments (UE1, UE2, UE3, UE4), the network respecti-

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vely assigns common resources for at least a number of the user equipments (UE1,UE2,UE3,UE4) or individual resources for each user equipment (UE1,UE2,UE3).

- 5 12. User equipment of a radio communication system, with means for determining a delay time for transmitting a signal on an uplink access channel (RACH), wherein the delay time is randomly determined based upon a probability distribution that increases in density with increasing delay.

Abstract

METHOD FOR UPLINK ACCESS TRANSMISSIONS IN A RADIO COMMUNICATION SYSTEM

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The invention relates to a method for uplink access transmissions in a radio communication system, a user equipment (UE1, UE2, UE3, UE4) determines a delay time for transmitting a signal on an uplink access channel (RACH), wherein the delay time is randomly determined based upon a probability distribution that increases in density with increasing delay.

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FIG 1

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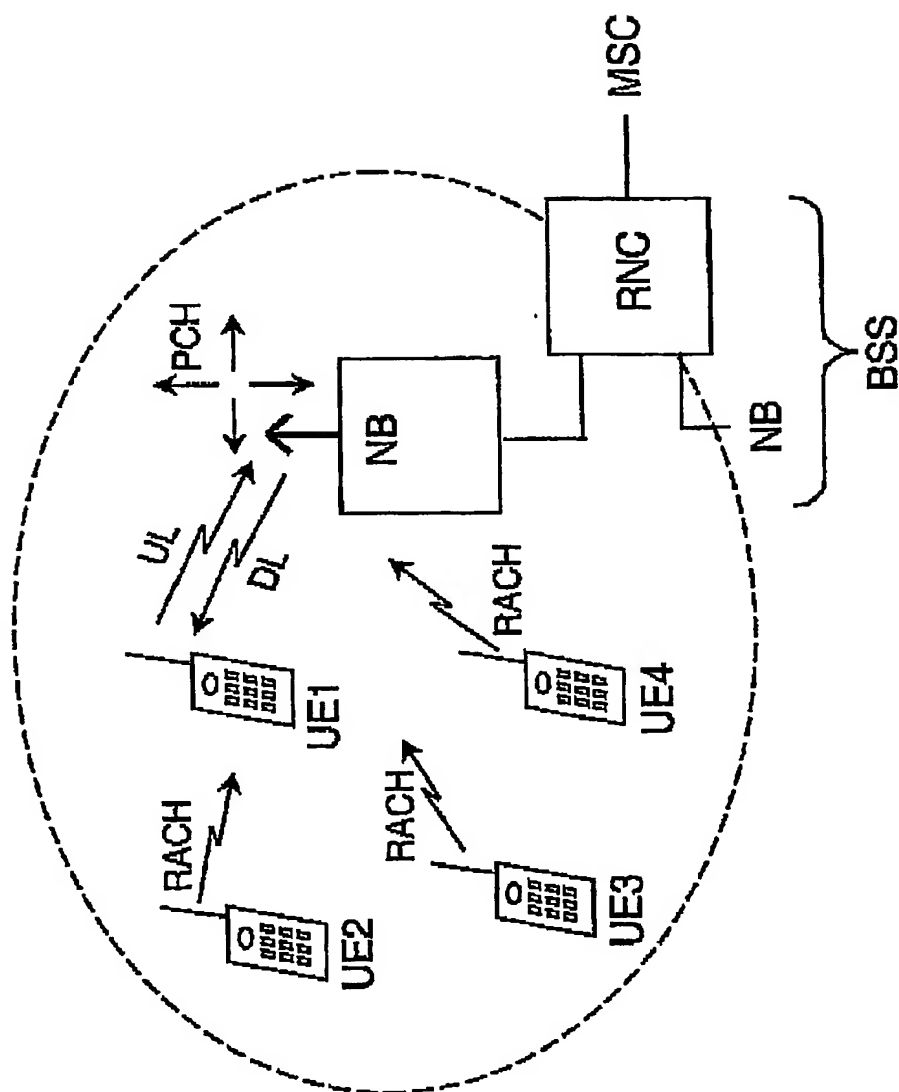
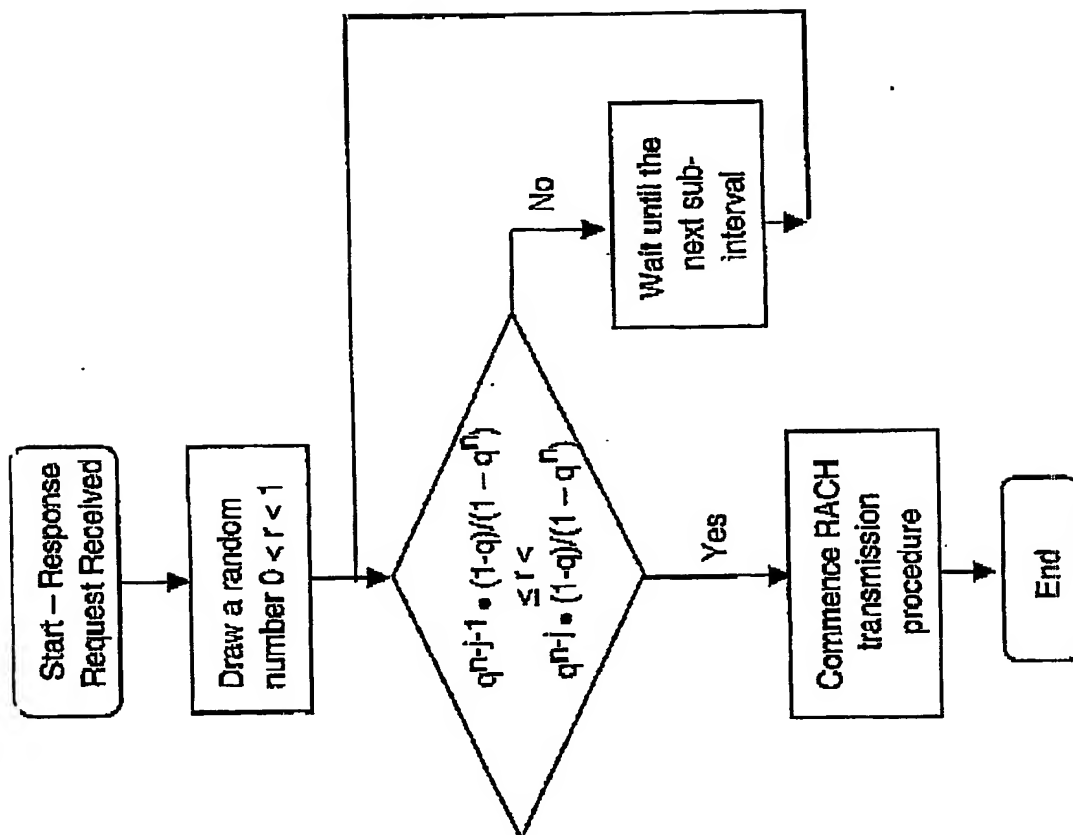


FIG 1

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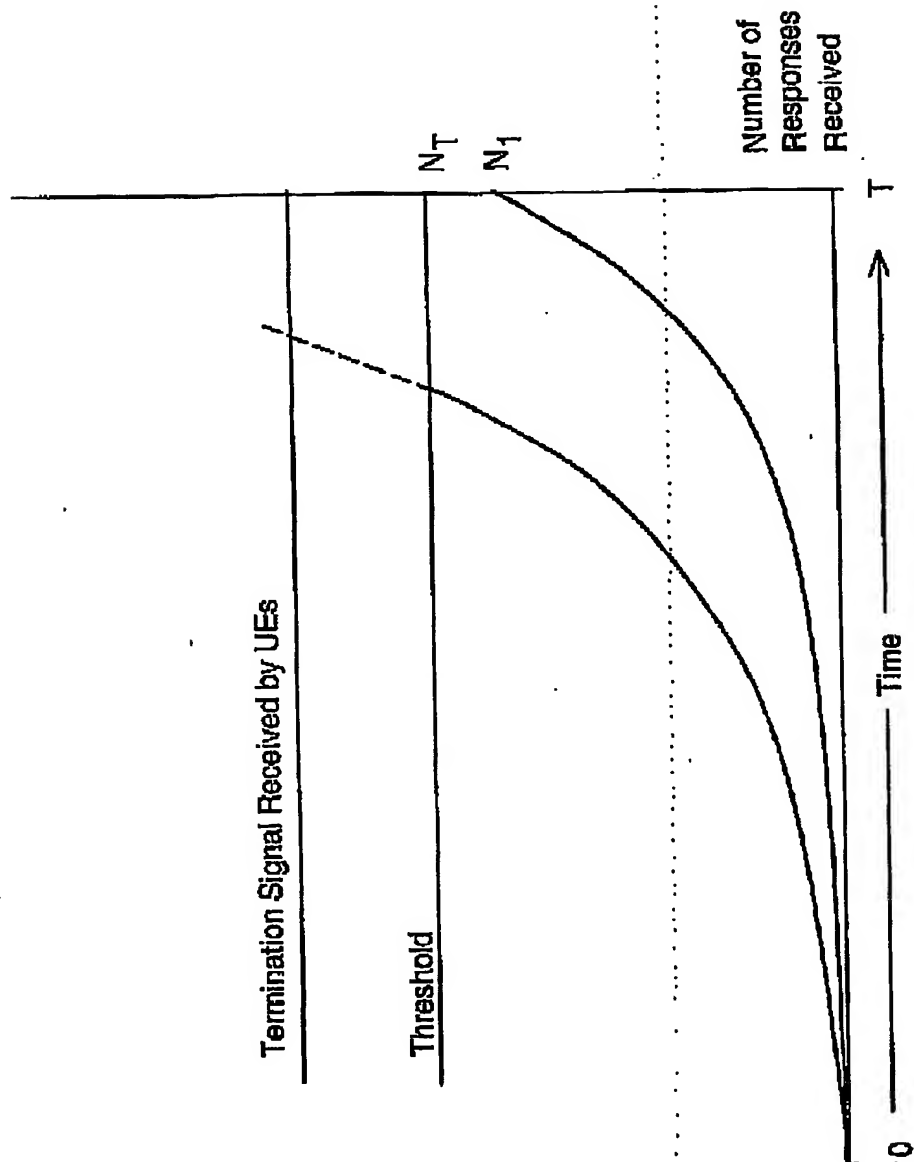
FIG 2



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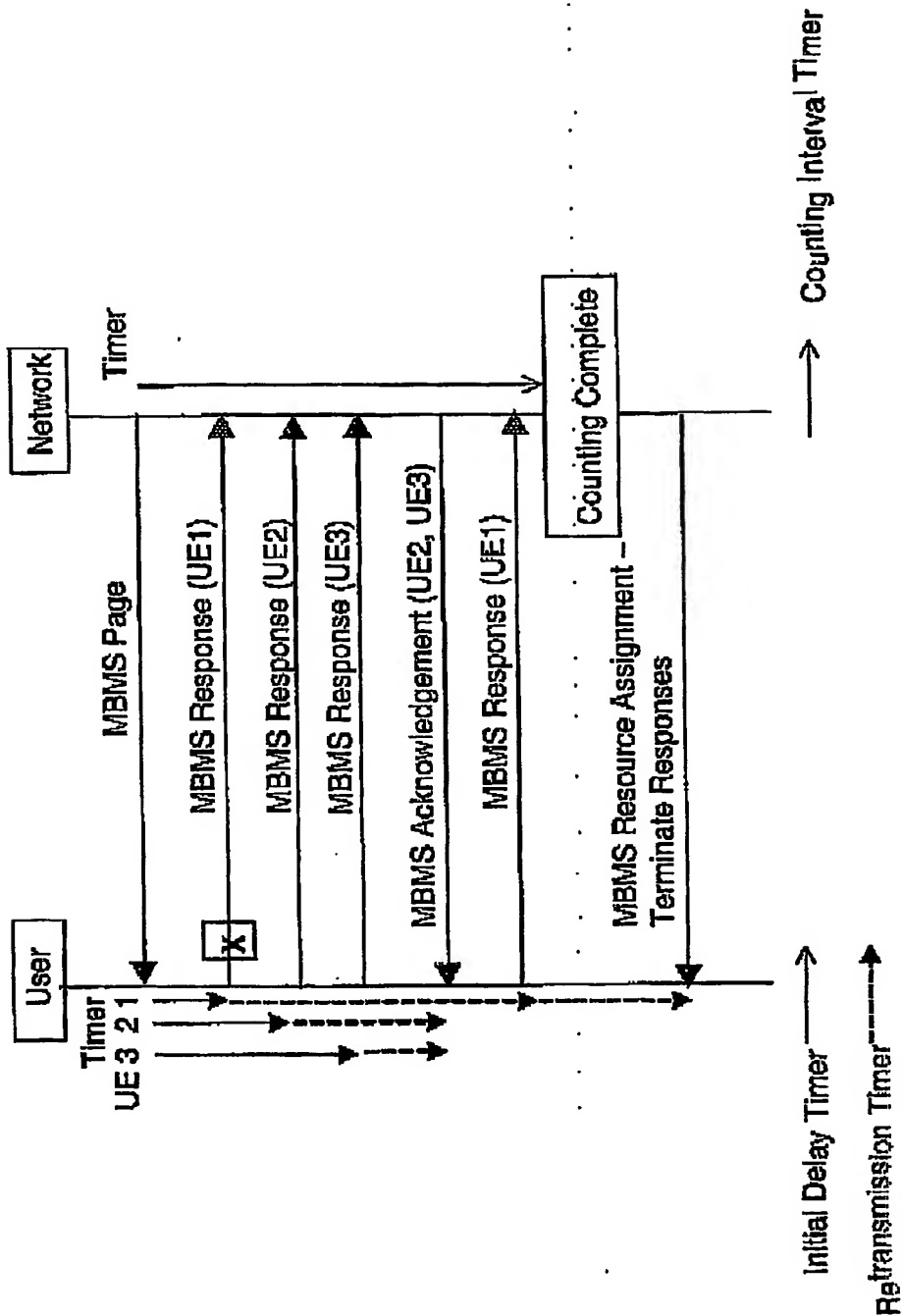
FIG 3



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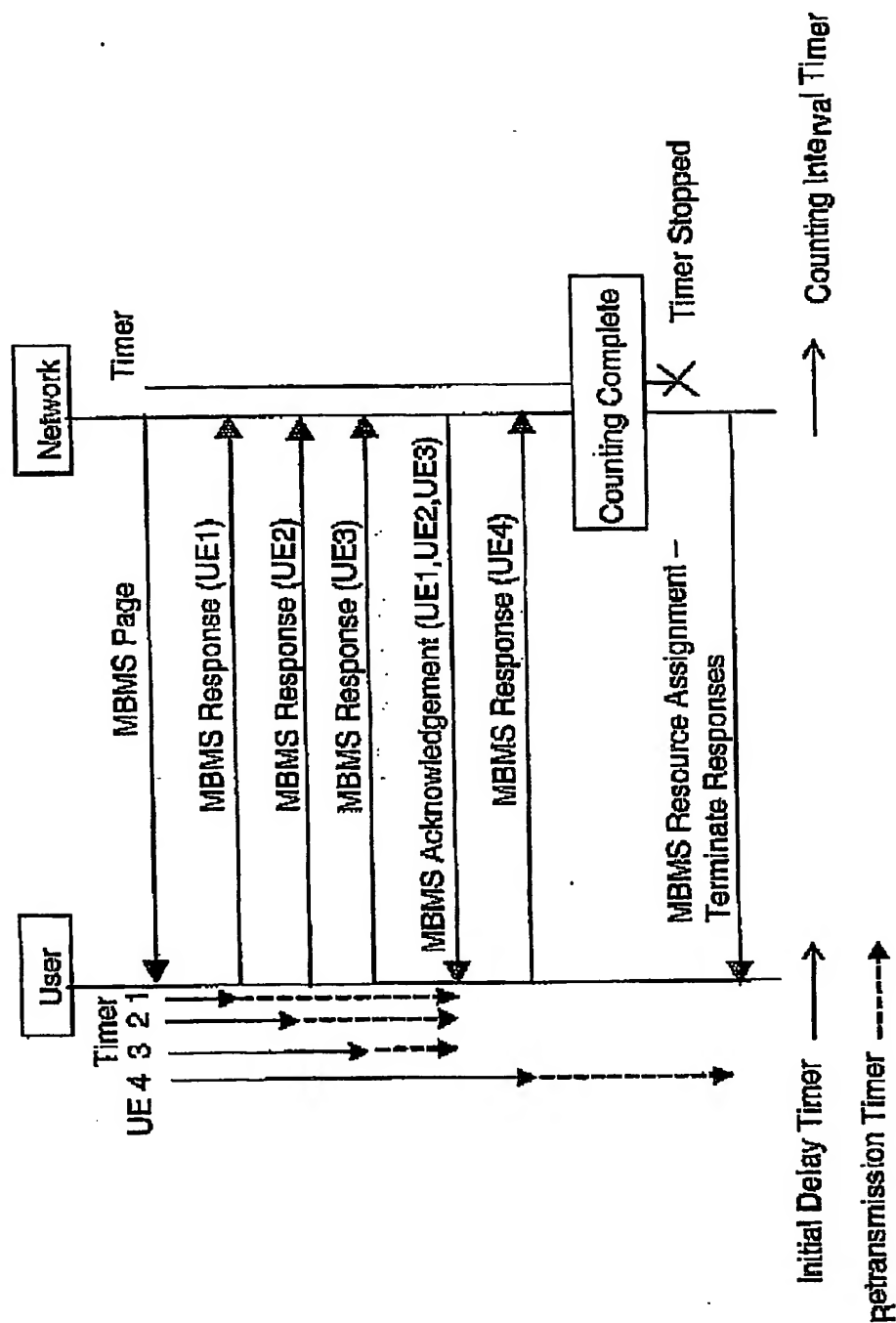
FIG 4



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FIG 5



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